

Abdominoplasty and Abdominal Contour Surgery: A National Plastic Surgery Survey

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Background: According to the American Society for Aesthetic Plastic Surgery's 2004 Cosmetic Surgery National Data Bank, during the last 7 years, the number of abdominoplasty procedures performed has increased 344 percent. A national report on abdominoplasty has not been since 1977. Grazer and Goldwyn's study reflects the preliposuction era of abdominal contouring surgery. The purpose of this study was to assess current trends in abdominal contouring techniques and associated procedures and the incidence of their complications.

Methods: The study was designed as a descriptive correlation survey evaluating the frequency of various abdominal contour techniques and complications among 3300 randomly chosen members of the American Society of Plastic Surgeons. There were 497 respondents, for a response rate of 15 percent.

Results: A total of 20,029 procedures were reported in the survey; 35 percent ($n = 7010$) were liposuction of the abdomen, 10 percent ($n = 2003$) were limited abdominoplasties, and 55 percent ($n = 11,016$) were full abdominoplasties. Survey data covered the plastic surgeon's demographics, techniques, and incidence of complications during a 12-month period.

Conclusions: The authors report the largest series of local and systemic complication rates and compare them with those of previously published abdominoplasty surveys. With respect to full abdominoplasty, lower complication rates for deep vein thrombosis (0.04 percent) and pulmonary embolus (0.02 percent) were seen. No deaths were reported. There was no correlation between a surgeon's years in practice and complication rates, in concordance with the earlier study by Grazer and Goldwyn. Despite more extensive abdominal contouring techniques and the addition of liposuction to abdominal contouring, the local and systemic complication rates coincided with previous complication rates, as outlined in other studies. (*Plast. Reconstr. Surg.* 117: 1797, 2006.)

Today, multiple surgical techniques are available for abdominal contouring in both men and women, based on variations in patients' anatomy and their goals, including liposuction, limited abdominoplasties, and full abdominoplasties, among others. According to the American Society for Aesthetic Plastic Surgery's 2004 Cosmetic Surgery National Data Bank, during the last 7 years, the number of abdominoplasty procedures has increased 344 percent.¹ The number of the various abdominoplasty procedures is likely to continue to increase in the near future, because of the growing demand for massive weight loss contouring procedures, an increase in the number of aesthetic surgery procedures in general, and an aging population

concerned with their appearance. A national survey on abdominoplasty was reported in 1977, reflecting the preliposuction era of body contouring surgery.² The advent of liposuction dramatically altered the field of body contouring surgery and vastly improved our ability to contour the abdomen. A national survey of complications associated with liposuction was reported in 1989,³ and another was reported by Hughes in 2001.⁴ There has been an ongoing debate about performing liposuction on an undermined abdominoplasty flap in an abdominoplasty patient in general, the use of wetting solutions, and the safety of combining plastic surgery procedures with abdominal contouring surgery. In view of the advances over the last two decades, we sought to determine trends and collect data on abdominal contouring procedures by means of a comprehensive randomized survey of the 4531 members of the American Society of Plastic Surgeons. The survey assessed trends, demograph-

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ics, and the techniques surgeons choose for abdominal contouring, how they performed these procedures, and their incidence and type of complications. A professional survey organization (Industry Insights, Inc., Columbus, Ohio) assisted in tabulating the results and analyzing the data.

MATERIALS AND METHODS

The study design was descriptive, using correlational data analysis to evaluate the frequency of use of various abdominal contour techniques and the frequency of complications encountered by board-certified/board-eligible members of the society. The survey instrument was distributed in October of 2003 and responses were collected in 4 weeks. The survey was reviewed and approved by the institutional review board of Rutgers University, New Brunswick, New Jersey. A three-page survey, which included a cover letter explaining the purpose of the study and requesting participation, was distributed to 3300 randomly selected members of the society over a 1-week period. No personally identifiable coding or reminder mailings were used. The survey instrument was structured so that every surgeon could complete it without a detailed chart review, and it took approximately 10 minutes to complete. A total of 497 responses (15 percent response rate) were received within 5 weeks,⁵ in time for processing. Based on the 497 responses, this study had a plus or minus 4 percent margin of error, at a 93 percent level of confidence. To ensure anonymity, the completed surveys were mailed, by the respondents, directly to Industry Insights, Inc. Upon receipt, the returned questionnaires underwent data examination to ensure that directions were followed and that the data reported were consistent, accurate, and complete. Detailed attributes and characteristics of the sample can be found in the demographics section.

The data findings were subject to nonsampling error, including nonbias response, which arises when subjects who respond to a survey differ significantly from those who do not. Since this was an anonymous survey, it was impossible to identify the nonresponders. Another limitation was that mailed surveys were subject to systemic bias as a result of respondent self-selection. Response was strongly influenced by the respondents' interest in the survey's subject matter. Statistical analyses were performed using SPSS version 8.0 software. Nominal data (e.g., frequencies of incidents, complications) were analyzed using chi-square statistics. Demographic data and surgeon characteristics were reported as percentages. Because of the

large number of respondents ($n = 497$), the appropriate tests of association used Pearson correlation (r) coefficients. Tests of significance were two-tailed, and p values were reported.

RESULTS

Demographics

This survey represented a well-distributed cross-section of surgeons. Ninety-two percent of respondents had been in practice for more than 5 years. Thirty-two percent had been in practice for more than 20 years. Interestingly, there were similar percentages of years in practice when the respondents were compared with the entire membership of the American Society of Plastic Surgeons (Table 1). Because of the low response rate to the survey (15 percent), we do not know whether the sample was typical of the general population of plastic surgeons.

Practice Classification

The respondents were asked to characterize themselves as primarily aesthetic, reconstructive, or hand surgeons. They were then asked to evaluate the nature of their practices from three different perspectives: amount of time spent, revenue generated, and number of procedures performed. Based on the number of procedures performed, respondents devoted 55 percent of their practices to aesthetic procedures, 35 percent to reconstructive surgery, and 8 percent to hand surgery. According to income, 65 percent of revenue was generated by aesthetic cases, 26 percent by reconstructive cases, and 7 percent by hand cases (Table 2). Clearly, aesthetic surgery was the most lucrative, according to the ratio of time spent to revenue generated. Krieger and Lee have written about the current economics of plastic surgery practices. The average practice percentage of aesthetic surgery increased from 27 percent in 1992 to 58 percent in 2002. They found that plastic surgeons have shifted their practice profiles from

Table 1. Comparison of Years in Plastic Surgery Practice between Respondents and the Members of the American Society of Plastic Surgeons

Years in Practice	Respondents ($n = 497$)	ASPS*
<5	8%	13%
6–10	22%	21%
11–15	21%	16%
16–20	18%	15%
>20	32%	35%

ASPS, American Society of Plastic Surgeons.

*American Society of Plastic Surgeons. Personal communication. June 8, 2005.

Table 2. Percentage of Practice Devoted to Procedures

Practice Focus	Procedures Performed (<i>n</i> = 473)	Revenue Generated (<i>n</i> = 424)	Time Spent (<i>n</i> = 413)
Aesthetic surgery	55%	65%	55%
Reconstructive surgery	35%	26%	35%
Hand surgery	8%	7%	8%
Other	2%	2%	2%
Total	100%	100%	100%

reconstruction to aesthetic surgery and have increased their case loads on average by 41 percent over the past 10 years, with the most likely intended goal of maintaining their incomes.⁵

General Information

A total of 20,029 abdominal contour procedures were performed in a 12-month period. The mean number of abdominal contour procedures performed in a year, by the respondents, was 40 (Table 3). Of the 20,029 abdominal contour procedures performed, 35 percent were liposuction of the abdomen, 10 percent were limited abdominoplasties, and 55 were full abdominoplasties.

Anesthesia

Abdominal contour procedures can be performed using local intravenous sedation, administered by either the anesthesiologist or the surgeon, or general anesthesia. During liposuction of the abdomen, 74 percent of the respondents used general anesthesia, 15 percent used intravenous sedation administered by the anesthesiologist, 9 percent used intravenous sedation administered by the surgeon, and only 2 percent used local anesthesia only. Plastic surgeons usually performed liposuction with anesthesiologists present, most likely because of their access to and familiarity with intravenous sedation and general anesthesia. For limited abdominoplasties, 82 percent of the respondents used general anesthesia, 11 percent used intravenous sedation administered by the anesthesiologist, 5 percent used intravenous sedation administered by the surgeon, and only 1 percent used local anesthesia for these procedures. During full abdominoplasty, 90 percent used general anesthesia, 7 percent used intravenous sedation administered by the anesthesiolo-

gist, and 2 percent used intravenous sedation administered by the surgeon; no one used local anesthesia alone. Plastic surgeons do not generally administer their own anesthesia, even when they have many years of experience ($r = -0.08$, not significant). Eighty-nine percent or more of the respondents used an anesthesiologist for all abdominal contour procedures. For any abdominal contour procedure, more than 75 percent of the respondents used general anesthesia. We did not ask whether the surgeons used epidural anesthesia for their abdominal contour procedures. The respondents were asked which cosmetic procedures they would perform concomitantly with a full abdominoplasty. Eighty-three percent would also perform liposuction of the thighs, 64 percent would also perform breast reduction, 64 percent would perform blepharoplasty, 49 percent would perform a brow lift, 40 percent would perform rhinoplasty, 26 percent would perform a face lift, and 12 percent would perform a face lift, blepharoplasty, and brow lift (Fig. 1).

Data Regarding Different Abdominal Contour Procedures

Liposuction of the Abdomen

The respondents were asked to give the average volume of wetting solution used to infiltrate the abdomen before liposuction. Forty-one percent of respondents used between 1000 and 1500 cc, 31 percent used between 500 and 1000 cc, 21 percent used more than 1500 cc, and 6 percent used less than 500 cc. The respondents were asked about the average volume removed with total liposuction of the abdomen. Thirty-nine percent remove between 500 and 1000 cc, another 39 percent remove between 1000 and 1500 cc, 15 percent remove more than 1500 cc, and 7 percent remove less than 500 cc. There was a strong significant relationship between the more wetting solution used and the increased volume removed from the abdomen during liposuction ($r = 0.65$, $p = .001$). Removal of an increased total volume of abdominal liposuction did not increase the risk of wound infection, blood transfusion, anesthesia

Table 3. Mean Number of Abdominal Contour Procedures in 12 Months (*n* = 497 respondents)

Practice Classification	Mean No. of Procedures by Respondents
Aesthetic surgeons	57
Reconstructive surgeons	25
Hand surgeons	10

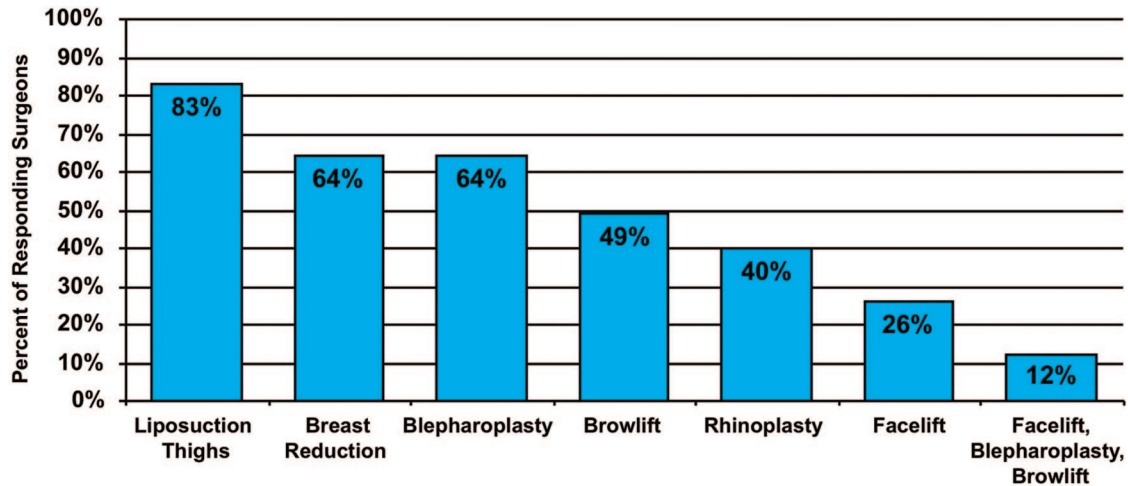


Fig. 1. Procedures that responding surgeons would perform along with a full abdominoplasty.

complications, pulmonary emboli, or malpractice actions. The respondents were asked what technique of liposuction they used for liposuction of the abdomen. The techniques included traditional, ultrasound-assisted, power-assisted, and external ultrasound-assisted liposuction. The majority of respondents, 70 percent, used traditional liposuction, 14 percent used power-assisted liposuction, 13 percent used ultrasound-assisted liposuction, 3 percent used external ultrasound-assisted liposuction, and 1 percent used another technique (Fig. 2). The respondents were asked whether they combined liposuction of the abdomen with liposuction elsewhere on the body. Ninety-seven percent combined abdominal liposuction with liposuction elsewhere and 3 percent did not. Seventy-seven percent combined abdominal liposuction with other aesthetic procedures, and 23

percent did not. Ninety-seven percent used an abdominal compression binder, and only 3 percent did not. On average, the respondents who used a compression binder did so for 24 days. For postoperative care after liposuction, 48 percent recommended massage, 10 percent recommended ultrasound, 8 percent recommended “ancillary care,” and 7 percent recommended something else (e.g., Endermologie, hot tub, and heat). Also, 90 percent of all abdominal liposuction procedures were performed in women and 10 percent were performed in men.

Limited Abdominoplasties

The limited abdominoplasty^{6,7} is often referred to as the mini-abdominoplasty^{8,9} or modified abdominoplasty.¹⁰ Ninety percent of the respondents performed limited abdominoplasties

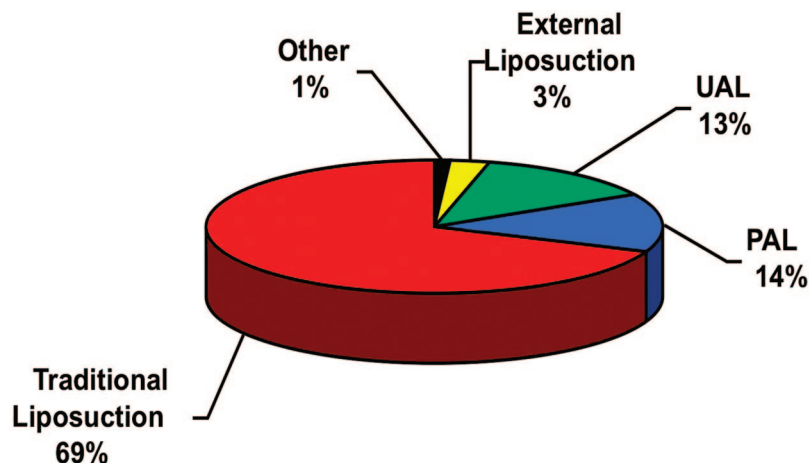


Fig. 2. Liposuction of the abdomen: techniques (n = 459). UAL, ultrasound-assisted liposuction; PAL, power-assisted liposuction.

and 10 percent did not. Of the respondents who performed limited abdominoplasties, only 5 percent used an endoscope. Ninety percent used drains for limited abdominoplasties and 10 percent did not. Those who did use drains used them for 6 days, on average. Ninety percent of the respondents used a compression binder and 10 percent did not. Of those who did, they used them for a mean period of 21 days. The respondents reported that 97 percent of their patients were female and 3 percent were male.

Full Abdominoplasty

One hundred percent of the respondents performed the full abdominoplasty procedure. Liposuction of the undermined abdominal flap as an adjunct to full abdominoplasty has been well described in the plastic surgical literature¹¹⁻¹⁶ and can be performed safely, provided certain guidelines are followed.¹⁷ The respondents were asked whether they performed liposuction of the abdominal flap with full abdominoplasty and, if so, what the average volume of liposuction was. Fifty-four percent performed liposuction of the abdominal flap with full abdominoplasty and 46 percent did not. Twenty-eight percent removed less than 500 cc from the abdominal flap, 18 percent removed between 500 and 1000 cc, 6 percent removed between 1000 and 1500 cc, and 3 percent removed more than 1500 cc (Fig. 3).

The surgeons were asked to specify the average volume of wetting solution infused for abdominoplasty. Thirty-seven percent did not use wetting solution for abdominoplasty, and 63 percent did. Twenty-three percent used between 500 and 1000 cc, 20 percent used less than 500 cc of wetting solution, and 15 percent used between 1000 and 1500 cc. Only 5 percent of the respondents used more than 1500 cc of wetting solution for an abdominoplasty. In comparisons of the volume of wetting solution infused for abdominoplasty versus liposuction of the abdomen, plastic surgeons used less wetting solution with full abdominoplasty (Table 4). With regard to liposuction else-

where at the time of abdominoplasty, 83 percent reported that they would perform liposuction of the thighs at the time of full abdominoplasty.

The surgeons were asked how they address diastasis of the rectus abdominis muscles. One hundred percent perform some muscle repair. Seventy-two percent plicate the rectus muscles vertically in the midline, 5 percent plicate the rectus muscle horizontally, and 23 percent use a combination of vertical and horizontal plication. The surgeons were asked, with regard to the skin closure in full abdominoplasty, what percentage of time they used a standard low horizontal incision, a T-closure, a panniculectomy, a high lateral tension abdominoplasty,^{18,19} or a circumferential abdominoplasty. We did not ask for the percentage of patients who were massive weight loss patients, and we did not distinguish between the circumferential lift and the lower body lift. The respondents used a standard low horizontal incision 63 percent of the time, a high lateral tension abdominoplasty 22 percent of the time, a panniculectomy 8 percent of the time, T-closure 5 percent of the time, and circumferential abdominoplasty 3 percent of the time. Plastic surgeons who performed the high lateral-tension abdominoplasty seldom used the standard low horizontal incision ($r = -0.78$, $p = 0.001$).

With regard to flap undermining and the abdominal pannus, the surgeons were asked for their preferred technique, which included making the lower incision and undermining the entire flap upward, pre-excising the pannus and then undermining the upper skin flap, and making the upper incision, undermining, and pulling it down to the lower incision before excising the pannus (“vest over pants”).²⁰ Eighty-one percent made the lower incision and undermined the entire flap upward, 13 percent pre-excised the wedge and then undermined the upper skin flap, and 7 percent used the “vest over pants” technique. The plastic surgeons were asked if they used drains for full abdominoplasty. Ninety-eight percent used drains

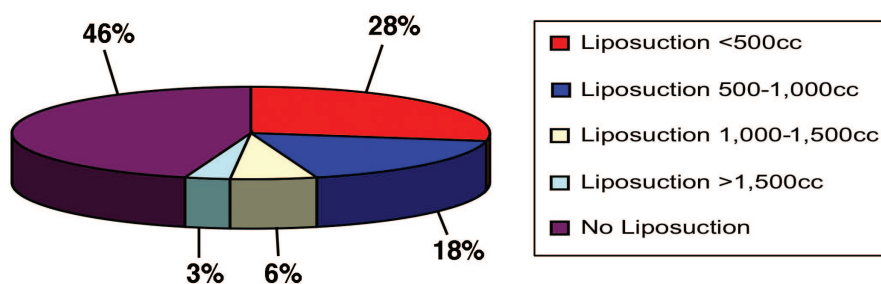


Fig. 3. Liposuction of the abdominal flap with full abdominoplasty.

Table 4. Comparison of the Volume of Wetting Solution Infused for Abdominal Liposuction versus Abdominoplasty

Liposuction of Abdomen (n = 497)		Abdominoplasty (n = 457)	
% Respondents	Volume Infused	% Respondents	Volume Infused
0%	0 cc	37%	0 cc
6%	<500 cc	20%	<500 cc
31%	500–1,000 cc	23%	500–1,000 cc
41%	1,000–1,500 cc	15%	1,000–1,500 cc
21%	>1,500 cc	5%	>1,500 cc

and 2 percent did not. For the responders who used drains for abdominoplasty, the average length of time was 8 days.

The surgeons were asked whether they used abdominal binders for full abdominoplasty. Eighty-five percent used them and 15 percent did not. Those who did use them for full abdominoplasty use them for a mean period of 24 days. Pre-existing abdominal scars above the level of the umbilicus, as with the right subcostal cholecystectomy scars, may affect the distal circulation of the flap.²¹ Yet, 80 percent of the respondents reported that they performed a full abdominoplasty with pre-existing scars above the levels of the umbilicus; 20 percent did not. One hundred percent performed a full abdominoplasty on patients with preexisting scars below the level of the umbilicus. Pregnancy will affect the results following a full abdominoplasty. The surgeons were asked how they advised their patients seeking full abdominoplasty about future pregnancies. Seventy-three percent recommended delaying abdominal contour surgery until after pregnancy, 16 percent performed alternative operations, if applicable, such as liposuction, 7 percent reported no difference in treatment, and only 4 percent performed abdominal contour surgery (full abdominoplasty).

Each plastic surgeon has his or her own technique for exteriorizing the umbilicus. The surgeons were asked how they usually exteriorize the

umbilicus. Thirty-one percent used a vertical slit and 21 percent made a horizontal slit. Forty-eight percent used some other designs when exteriorizing the umbilicus for full abdominoplasty. The surgeons were also asked whether they perform a full abdominoplasty in conjunction with intra-abdominal surgery (e.g., cholecystectomy or hysterectomy). Seventy-eight percent would perform a full abdominoplasty in conjunction with intra-abdominal surgery, and 22 percent would not. We did not inquire specifically about complications related to combining abdominoplasty with intra-abdominal surgery. With respect to the amount of time needed to perform a typical full abdominoplasty, 60 percent took between 2 and 3 hours, 33 percent took less than 2 hours, and 8 percent took 4 hours or more. The surgeons were asked what percentage of their total abdominoplasty cases comprised female or male patients. They reported that 95 percent of their patients were female and 5 percent were male.

Complications

Surgeons were asked to list how often complications occurred when they performed abdominal contour procedures over the previous 12 months. There was no correlation between a plastic surgeon's length of time in practice and the incidence of local and systemic abdominal contour

Table 5. Local Abdominal Contour Surgery Complications

Complications	Liposuction	Limited Abdominoplasties	Full Abdominoplasties
Contour irregularity	9.20%	4.90%	5%
Major skin necrosis (requiring reoperation)	0%	1%	1%
Minor skin necrosis (healed spontaneously)	0%	4%	4.40%
Scar revision	0.03%	2.40%	4.90%
Hematoma	0.04%	0.08%	1.40%
Wound infection	1%	0.02%	1.10%
Wound dehiscence	0%	1%	1%
Umbilical abnormality (requiring reoperation)	0%	0.05%	1.20%
Dissatisfied patients (unfulfilled expectations)	3.30%	2.90%	2.20%
Need for second surgery	3.50%	2.40%	3.40%

Table 6. Systemic Abdominal Contour Surgery Complications

Complications	Liposuction	Limited Abdominoplasties	Full Abdominoplasties
Local anesthesia (i.e., wetting solution)	0%	0%	0%
Major anesthesia	0%	0%	0%
Malpractice action	0%	0%	0.01%
Blood transfusion	0%	0.01%	0.04%
Deep vein thrombophlebitis	0%	0%	0.04%
Pulmonary embolism	0%	0%	0.02%
Pulmonary fat embolism	0%	0%	0%
Intra-abdominal perforation	0%	0%	0%
Deaths	0%	0%	0%
Readmission to hospital	0.01%	0.01%	0.05%

surgery complications; this is consistent with Grazer and Goldwyn’s abdominoplasty survey.² The complication section was divided into two categories, local and systemic, for each of the abdominal contour surgery procedures. The local and systemic complications of liposuction, limited abdominoplasties, and full abdominoplasties were then compared (Tables 5 and 6). Our data on local and systemic complications did not distinguish whether or not liposuction of the abdominal flap was performed with full abdominoplasty. We then compared our data on full abdominoplasty to data from four previous surveys that addressed both local and systemic abdominoplasty complications (Table 7).

Local Complications

Common local complications for the abdominal contour procedures include contour irregularities, skin necrosis (minor and major), scar revision, hematoma, seroma, and wound infection.²²⁻²⁶ Other local complications, such as necrotizing fasciitis, Ogilvie’s syndrome, wound dehiscence, umbilical deformity requiring reoperation, dissatisfaction because of unfulfilled expectations, and the need for a second surgery, have been reported. Complications specific to abdominoplasties are entrapment of the lateral femoral cutaneous nerve, ilioinguinal nerve, and iliohypogastric nerves and neuroma formation of these peripheral nerves^{22,24,25} (Table 5). In our study, the most common postoperative compli-

Table 7. Comparison of Results of Abdominoplasty Complications

	Matarasso et al.	Hester et al. ^{31*}	Grazer and Goldwyn ^{2†}	Pitanguy ^{23‡}	Teimourian and Rogers ^{3§}
No. of procedures	11,016	563	10,490	539	26,562
Local, %					
Necrosis minor	4.4	0.9% (minimal slough)	5.4 (wound dehiscence)	1.4	—
Necrosis major	1.0	—	—	0.3	—
Seroma	—	2.5%	—	5.8	8.58
Infection	1.1	1.1	7.3	—	—
Blood loss	<1.0	14.2	—	—	—
Hypertrophic scars	<1.0	—	—	3.7	—
Hematoma	1.4	—	6	—	—
Wound infection	1%	—	—	—	—
Dehiscence	1%	—	—	0.3	—
Umbilical abnormality	1.2	—	—	0.3	—
Dissatisfied patient	2.2	—	—	—	—
Need for second operation	3.4	—	—	—	—
Scar revision	4.9	—	—	—	—
Contour irregularity	5.0	—	—	—	—
Systemic, %					
Deep vein thrombosis	0.04	—	1.1	—	0.29
Pulmonary embolism	0.02	1.1	0.8	—	0.25
Pulmonary fat embolism	0	—	—	—	0.02
Blood transfusion	0.04	—	—	—	0.04
Death	0	—	0.16	—	0.04
Anesthesia complications	0	—	—	—	0.04
Readmission to hospital	0.05	—	—	—	—
Malpractice action	0.01	—	0.18	—	—

*Abdominoplasty versus abdominoplasty and intra-abdominal/pelvic abdominoplasty with other aesthetic procedures.

†Abdominoplasty by survey.

‡Abdominoplasty alone.

§Abdominoplasty versus suction-assisted lipectomy versus dermolipectomy by survey.

cation of abdominal liposuction was contour irregularity, with a reported rate of 9.2 percent compared with 4.9 percent for limited abdominoplasties and 5 percent for full abdominoplasties. Potential wound-healing problems with full abdominoplasty, particularly in the triangle from the umbilicus to the pubis, have been reported.¹² In Grazer and Goldwyn's survey, the reported rate of skin loss was high (54 percent had a "few") and the need for skin grafts was high (85 percent had a "few"). Surgeons were not asked whether they perform abdominoplasties on smokers in this survey or Grazer and Goldwyn's survey. Perhaps there is better patient screening, to avoid smokers, and the extent and type of undermining (discontinuous) have changed. In full abdominoplasty, the reported rate of minor skin necrosis was 4.0 percent; the reported rate of major necrosis was 1.0 percent. Hughes' study reported a skin slough complication rate of 0.09 percent, but there was no distinction between minor and major skin slough.⁴ We found a slightly moderate relationship between major skin necrosis and malpractice action ($r = 0.38, p = 0.001$). There was a moderately strong significant relationship between wound dehiscence and skin necrosis requiring reoperation ($r = 0.51, p = .001$). There was a slightly moderately significant relationship between wound dehiscence and increased numbers of procedures ($r = 0.37, p = 0.01$). Thus, the more procedures that were performed, the greater the probability of wound dehiscence. Von Uchelen et al.'s retrospective study found a high rate (36 percent) of skin necrosis with the T-type abdominoplasty closure compared with horizontal closure (4.6 percent).²⁶ Undermining the flap in an inverted "V" fashion, avoiding operating on active smokers, avoiding excess tension on the flap closure, limited flap thinning, and avoiding excessive flap liposuction are principles that have decreased the incidence of wound-healing problems. As one would expect, there were moderate, significant correlations between a dissatisfied patient and wound infection ($r = 0.32, p = .001$); wound dehiscence ($r = 0.41, p = .001$); need for second surgery ($r = 0.46, p = .001$); umbilical abnormality ($r = 0.31, p = .001$); contour irregularity ($r = 0.32, p = .001$); and major skin necrosis ($r = 0.32, p = .001$).

Systemic Complications

Systemic complications include local anesthesia complications (wetting solution), major anesthetic complications, blood transfusion, deep vein thrombosis,³ pulmonary embolism,² fat emboli syndrome,^{27,28} intra-abdominal perforation,²⁴ death,²⁹ toxic shock syndrome,³⁰ readmission to the hospital,² and malpractice action.² The sys-

temic complications in our survey are reported in Table 6. A majority of the respondents (78 percent) would perform a full abdominoplasty in conjunction with intra-abdominal surgery. We did not inquire about the incidence of complications when a full abdominoplasty was performed with other major surgical procedures. Some authors have reported higher morbidity rates when abdominoplasty is performed along with other procedures,^{28,32} and some have reported no increase in the incidence of complications when abdominoplasty is performed concomitant with other procedures.³¹ No deep vein thromboses or pulmonary emboli were reported for liposuction or limited abdominoplasties in our survey, but there was a 0.04 percent incidence of deep vein thrombosis and 0.02 percent incidence of pulmonary embolus. The incidence of deep vein thrombosis and pulmonary embolus was lower than that in previously reported national surveys.^{2,3,31} There may have been a decrease in the reported incidence of deep vein thrombosis and pulmonary embolism because of the increased emphasis that has been placed on preventing these complications. These complications have continued to be reported for liposuction, limited abdominoplasties, and full abdominoplasties and have resulted in significant morbidity and mortality rates.⁴ In Grazer and Goldwyn's survey, 35 percent of the responding surgeons had their patients ambulating in 24 hours, 27 percent did so by 72 hours, and 10 percent waited 4 days or more before allowing their patients to ambulate. In Grazer and Goldwyn's survey, six of the 17 deaths reported by 958 surgeons were due to pulmonary emboli.² Sixty percent of the 15 deaths in Teimourian and Rogers' survey were due to thromboembolism.³ In Grazer and de Jong's 2000 survey of fatal outcomes from liposuction, the mortality rate was assessed at one in 5224 procedures, or 19.1 per 100,000 procedures, and 23 percent of the deaths were attributed to pulmonary embolism.²⁹ However, their survey was considered flawed.³³ Hughes reported the incidence of deep vein thrombosis and pulmonary embolism in the 2000 American Society for Aesthetic Plastic Surgery survey on lipoplasty and lipoplasty combination procedures, which reported on 94,159 procedures. The rate of deep vein thrombosis was one per 3040 procedures (0.0329 percent), and the rate of pulmonary embolism was one per 3759 procedures (0.0266 percent).⁴ Keyes et al. reported that in the 2-year period monitored by the American Association for Accreditation of Ambulatory Surgery Facilities' quality improvement and peer review program, 14

patients developed deep vein thrombosis and 17 patients developed pulmonary embolism in 411,670 procedures. Four of the deep vein thrombosis patients underwent abdominoplasty and five had liposuction. The incidence of pulmonary embolism in their study was one in 24,216 procedures. Of the seven reported deaths in their study, six were secondary to pulmonary embolism. Of the six fatal pulmonary emboli cases in their study, four patients had undergone abdominoplasty and one patient had undergone abdominal liposuction.³⁴

Preventive steps should be taken to minimize the risk of deep vein thrombosis and pulmonary embolism, with sequential venous compression boots before induction of anesthesia, early ambulation, and some use of pharmacologic agents, such as low molecular weight heparin; some surgeons use epidural anesthesia. Patients with a personal or family risk of coagulopathy should be screened for lupus anticoagulant, anticardiolipin antibodies, antithrombin III, and proteins C and S. Use of oral contraceptives and hormone replacement therapy is considered a potential risk factor.³⁵ Patients should be questioned about whether they have a history of deep vein thrombosis and pulmonary embolism, which would make them high-risk patients, or other risk factors; advanced age and obesity are also risk factors. There were no reported pulmonary fat emboli for liposuction, limited abdominoplasty, and full abdominoplasty in this survey. Teimourian and Rogers' national survey of complications associated with suction lipectomy found one fat embolus in 75,591 liposuction procedures and four fat emboli in 26,562 abdominoplasties. Only one of the five reported cases resulted in a death.³ Our respondents reported no blood transfusions for liposuction and a 0.01 percent incidence of blood transfusion for limited abdominoplasties. The incidence of blood transfusions after abdominoplasty (0.04 percent) was constant when compared with Teimourian and Rogers' 1989 survey.³ None of our respondents reported deaths due to liposuction, limited abdominoplasty, or full abdominoplasty. Grazer and Goldwyn's 1977 survey had a mortality rate of 0.16 percent for 10,600 full abdominoplasties (17 deaths). Teimourian and Rogers' survey had an incidence of 0.04 percent for 26,562 abdominoplasties (11 deaths). The American Society for Aesthetic Plastic Surgery's 2001 lipoplasty survey found that the mortality rate for liposuction alone was one per 47,415 procedures (0.0021 percent). For liposuction performed with other procedures, excluding abdominoplasty, the

mortality rate was one per 7314 procedures (0.0137 percent), and for liposuction combined with abdominoplasty, it was one per 3281 procedures (0.0305 percent), a rate 14 times greater than that for liposuction alone.⁴ There are reasons that may explain why there were no reported deaths from liposuction in our study. Improved patient safety, based on the 1998 recommendations of the Lipoplasty Task Force,⁴ resulted in modifications in liposuction technique and patient evaluation. The task force³⁶ reported a liposuction mortality rate of 0.02 percent, or one death in 5000 liposuction procedures. Hughes⁴ reported that the incidence of death associated with liposuction was one per 47,415 procedures. Therefore, our survey may not have reported enough abdominal liposuction procedures ($n = 7010$) to be significant. This study reveals that years of surgical experience does not affect the complication rate. The complication rates are similar for surgeons in practice more than or less than 8 years, notwithstanding the number of abdominoplasties they perform. There were moderate significant correlations between readmission to the hospital and deep vein thrombosis ($r = 0.62, p = .001$), pulmonary fat emboli ($r = 0.47, p = .001$), pulmonary emboli ($r = 0.46, p = .001$), and blood transfusion ($r = 0.40, p = .001$).

There was no significant correlation between years in practice and the following complications: major skin necrosis, minor skin necrosis, contour irregularities, scar revision, hematoma, wound infection, patient dissatisfaction, need for second surgery, deep vein thrombosis, pulmonary embolism, anesthesia complications, malpractice action, and readmission to the hospital. Our survey of abdominoplasty complications is particularly germane in view of the moratorium on combination abdominoplasty and liposuction procedures in Florida, because of the eight patient deaths since the summer of 2002.³⁷ It is likely that the health department and government legislators will look closely and more data will be forthcoming.

DISCUSSION

There are both strengths and limitations in using the survey methodology as a form of reporting. The strengths of the study are its scope, size, and broad range. The survey represents 15 percent of all abdominal contour surgery procedures performed by American Society of Plastic Surgeons respondents in the United States in a 12-month period. It is the largest survey to deal with abdominoplasty surgery and its complications

since the seminal 1977 study by Grazer and Goldwyn. A survey deals with more than superficial and demographic issues or a single surgeon's experience reporting across a broad, nongeographical, or culturally limited population. The strengths of this survey are as follows: it involves a random sampling of members of the American Society of Plastic Surgeons; it is current; and it represents a total of 20,029 abdominal contour procedures (7010 liposuctions, 2003 limited abdominoplasties, and 11,016 full abdominoplasties). The data findings are subject to nonsampling error, including nonbias response, which arises when subjects who respond to a survey differ significantly from those who do not. No deaths from abdominal contour procedures were reported by our respondents. This survey was self-reported, and 85 percent of those surveyed did not respond. Plastic surgeons who have experienced these patient deaths most likely chose not to respond to the survey. Lastly, we can only report the data that were collected. In the medical literature, liposuction deaths have been caused by pulmonary embolism and pulmonary edema,³⁸ necrotizing fasciitis or overwhelming infection, fat embolism with or without hypovolemia, intestinal perforation, pulmonary embolus, endotracheal tube dislodgement, anesthesia machine failure, and improperly trained practitioners performing the procedure.³⁹ The incidence of complications is higher with prolonged procedures⁴⁰ and with outpatient aspiration greater than 5000 cc.⁴¹ One of the disadvantages of this methodology is that the surgeons who completed the survey were asked to answer the questions as to the percentage of patients rather than the number of patients operated on. Busy surgeons may not have had enough time to carefully review each chart, and their recollections as to the actual number of patients may not be as accurate. One of the limitations of a survey study is that it subjects the data to some significant biases. We attempted to correct for selection bias by randomly selecting members of the American Society of Plastic Surgeons and by guaranteeing the anonymity of the respondents. Interestingly, we found that the incidence of postoperative complications did not change with the number of years the plastic surgeon was in practice. Grazer and Goldwyn also reported that complications were noted occur at approximately the same frequency at various years in training.²

Unfortunately, we did not include all of the questions in our survey that we should have. The following additional questions should have been included:

1. What percentage of time do you use epidural anesthesia with or without intravenous sedation for liposuction, limited abdominoplasty, and full abdominoplasty?
2. What percentage of time do you use mechanical devices and pharmacologic agents to prevent deep vein thrombosis?
3. What is your incidence of postoperative abdominal seroma following abdominal contour surgery?
4. How do you manage smokers undergoing full abdominoplasty?
5. What is your incidence of superficial nerve entrapment complications (lateral femoral cutaneous nerve, ilioinguinal nerve, and iliohypogastric nerve) with limited or full abdominoplasty?
6. How would you distinguish complications after full abdominoplasty versus those after full abdominoplasty with abdominal liposuction?
7. What is your incidence of complications when a full abdominoplasty is combined with other procedures (i.e., intra-abdominal, facial)?

In addition, we should have differentiated between the complications of abdominoplasty patients who had liposuction of their undermined flaps and the complications of those who did not. Although 56 percent of the respondents performed liposuction of the abdominal flap, we did not ask whether there was an increase in complications with this practice. Recently, there has been a significant increase in the number of massive weight loss patients seeking abdominal contouring surgery. This will be an interesting subset of patients to evaluate. Perhaps a follow-up study will afford the opportunity to address these questions.

Both ICD-9 and CPT codes are available for aesthetic procedures. Computer software is also available that plastic surgeons can use to code their diagnostic and procedural data. Perhaps in the future plastic surgeons will utilize this software for this purpose. This (as well as the Internet) would allow quick access and accurate data collection for future surveys. Some complication patterns were noted when the complication rates of liposuction, limited abdominoplasty, and full abdominoplasty were compared. As expected, in general, the local and systemic complication rates were greater for full abdominoplasty than for limited abdominoplasty and abdominal liposuction. Noteworthy exceptions to this were the higher complication rates for contour irregularities with

liposuction (9.2 percent) when compared with limited abdominoplasty (4.9 percent) and full abdominoplasty (5 percent). There was a slightly higher rate of patient dissatisfaction, based on unfulfilled expectations, with abdominal liposuction and need for second surgery with liposuction of the abdomen compared with limited and full abdominoplasties. This underscores the need for carefully reconciling the patient's anatomy with an appropriate procedure, to avoid performing a less invasive procedure with which the patient ultimately will be dissatisfied.

CONCLUSIONS

We report the experience of 497 board-certified plastic surgeons who performed 20,029 abdominal contour procedures over a 12-month period. Fifty-five percent of the procedures were full abdominoplasties, 35 percent were liposuction procedures, and 10 percent were limited abdominoplasties. Ninety-two percent of the surgeons had been in practice for more than 5 years. Fifty-seven percent classified themselves as aesthetic surgeons, 25 percent classified themselves as reconstructive surgeons, and 10 percent classified themselves as hand surgeons. There was a strong, significant relationship between the more wetting solution used and the increased volume removed from the abdomen during liposuction. Removal of an increased total volume of abdominal liposuction did not increase the risk of wound infection, blood transfusion, anesthetic complications, pulmonary embolism, and malpractice actions. Contour irregularities (9.2 percent) were the most common local complication of abdominal liposuction in 7010 procedures. Respondents reported the largest series of complications in the 55 percent full abdominoplasty procedures ($n = 11,016$). With respect to full abdominoplasty, lower complication rates for deep vein thrombosis (0.04 percent) and pulmonary embolus (0.02 percent) were reported in our study than in previous reports. No deaths were reported in this survey. We found that, despite more extensive techniques and the addition of liposuction to a full abdominoplasty, complication rates were similar to those in previous reports. Moreover, there was no correlation between a surgeon's years in practice and complication rates.

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